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AUTHOR Humphrey, David A.
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ABSTRACT

Tentative formulas for calculating the cost of maintaining educational communications equipment are proposed. The formulas are based on a survey of campuses of the State University of New York. The survey analyzed the types of equipment to be maintained, types of maintenance, who uses the equipment, who services the equipment, and the cost structure of equipment maintenance. Two types of maintenance were determined: scheduled, which includes preventative maintenance, cleaning, and operation of equipment; and demand, which includes all nature of repairs, corrective maintenance, and refurbishing of equipment. The three types of equipment covered are television, audiovisual, and special or auxiliary equipment. The formula for television equipment maintenance is 4.42% of total capital investment. Of this 2.45% is spent on personnel and 1.97% on supplies and expenses. For audiovisual equipment, the formula is 6.22% of total capital investment, broken down into 3.92% for personnel and 2.7% for supplies and expenses. Specialized equipment is that which could best be assigned to a service contract. (JK)

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The Cost of Maintaining Educational Communications Equipment

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David A. Humphrey
Office of Educational Development
State University of New York

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This morning we will be concerned with the presentation of a model formula which has been designed to assess and budget for the costs incurred in maintaining educational communications equipment.

The development and application of the formula is of such a nature as to allow its use by all agencies which have responsibility for this type of equipment, regardless of the size of the agency or the kind and type equipment possessed. The formula which has been devised makes it possible to isolate and calculate needs in the two major areas of equipment maintenance expenses, personnel and repair parts.

First, let's consider why the formula is necessary. A slow but steady increase in the use of new communications media in college and school

instruction started in the early 1950's when the educational institutions in this country began to expand to meet the needs of unprecedented numbers of students. Since then, closed circuit television systems, language laboratories, audio-tutorial laboratories, audio-visual presentation systems for large lecture halls, computer-assisted instruction centers, and a whole range of new communications equipment have been purchased for use in the classroom and increasingly for use by students in self-study. This equipment represents a new kind of capital investment for education, an investment in the technological improvement of instruction.

As an example of the scope of this investment, consider that the State University of New York, during the 1960's spent approximately $25 million for new educational communications equipment, in providing the kinds of resources enumerated previously at each of several campuses.

When analyzed from the standpoint of a single inventory for all acquisitions of this type, it can be determined that a sizeable increase has occurred, both in the total number of items and their dollar value. Today the total value exceeds $1,000,000 at several campuses.

One of the problems inherent in using these new media for instruction is the problem of maintaining the equipment. It is clear that without adequate maintenance the media soon become a useless collection of hardware cluttering the campus. Too often, schools and colleges have been willing to make the initial capital investment in this new instructional equipment, but have been unwilling to make the annual expenditures necessary for a

maintenance program that would keep the equipment operating. As a result, instructional programs which attempt to utilize new media in teaching and learning begin to bog down with inoperable equipment. Although adequate maintenance will not guarantee the effective use of new media in instruction, it is a surety that the use of communications technology in instruction cannot proceed without it.

One of the problems that the educational communications centers have confronted is the maintenance of campus communications equipment, most of which has been acquired in the recent past. Without adequate experience with this equipment there has been no way to properly estimate the cost of an adequate equipment maintenance program. The literature, manufacturers, and rules of thumb, which suggest that 10% of the cost of a closed circuit television system should be budgeted annually for maintenance, have been of little assistance in justifying maintenance budgets to campus administrations, or to state budget examiners. Consequently, program funds were being siphoned, often unwittingly and in annually increasing amounts, for equipment maintenance.

Because of the increasing importance of this situation, coupled with the reliability an educational communications center must place on equipment for the success of its program, a study was conducted to establish an educational communications equipment maintenance formula for use as a management tool by educational communications centers on campuses of the State University of New York. The primary purpose was to develop

techniques for budgeting the anticipated annual expenditures to be incurred in maintaining all educational communications type equipment.

Results of the study provide three separate educational communications equipment maintenance formulas: (1) television, (2) audio-visual, and (3) specialized or auxiliary equipment. The formulas derived may be employed by any agency, educational or commercial, regardless of size, in maintenance budgeting. A further result of the formula is the provision of an evaluation base for determining the effectiveness and efficiency of an operating educational communications equipment maintenance program.

The formulas that have evolved will achieve dollar figures that can readily be applied to an educational communications center, or other appropriate agencies' annual budget request.

Next, we should consider the nature of the study conducted.

The primary assumption that provided the framework for the study was that annual maintenance costs could be directly related to the total dollar replacement cost of all the equipment maintained by the educational communications center. This places a responsibility on the center to keep an inventory of all communications equipment on the campus for which it had maintenance responsibility, and to calculate the replacement cost of this inventory annually, adjusting as necessary for inflation and other price increases.

Thus, a primary problem of the study was to find some empirical basis for calculating the percentage of the inventory replacement value that should be budgeted for maintenance.

The study included an analysis of educational communications equipment maintenance problems on State University campuses and a survey of colleges, schools and television stations both in and out of New York that had substantial data on the actual costs of equipment maintenance over several years. The analysis examined the types of equipment to be maintained, types of maintenance, who uses the equipment, who services the equipment, and the cost structure of equipment maintenance. The survey included contacting over 75 educational institutions, commercial and educational broadcasting stations, manufacturers and professional and engineering societies regarding the costs of their maintenance programs. Data on equipment inventory value and expenditures for equipment maintenance were compiled for thirty-one of these colleges, school districts and television stations.

In examining equipment maintenance programs at the agencies surveyed, it was found that there was a division of labor on maintenance. Audio-visual service departments did the maintenance on "A-V equipment", television departments did the maintenance on "TV equipment" and other "electronic systems equipment," while "highly specialized items of equipment" such as computers, photography and motion picture equipment, plus the often neglected general office equipment, were generally maintained by commercial companies through service contracts. This more or less traditional division of labor had, in many cases, simply survived when educational communications centers were established by merging previously separate audio-visual and television centers. As a result, some apparent anomalies in maintenance programs were found such as the technician in the A-V department would have

responsibilities for maintaining portable TV equipment while the technician in the TV department would maintain the still and motion picture projectors, or the "film chain," used in television production. Nonetheless, there was a certain pragmatic logic in organizing educational communications equipment maintenance programs in terms of this three-way split of responsibilities: (1) A-V equipment (2) TV and communications systems equipment, and (3) special equipment.

This general consistency in classification of equipment emerged when a few guidelines were established for sorting a piece of educational communications equipment into one of these three categories. The guidelines were simply answers to the following set of questions:

1. Who operates the equipment?
2. What kind of skills are needed to service the equipment?
3. Is the equipment primarily electro-mechanical or electronic?
4. Is the equipment primarily used as a single item or as a system of equipment?
5. Does the equipment require "scheduled maintenance" or can it be handled on the basis of "demand maintenance"?
6. How much does the equipment cost?

A-V equipment is primarily operated by teachers and students in classrooms or self-study environments. It is primarily electro-mechanical, single item equipment such as a 16mm film projector, although electronic components are being used in this type of equipment as technological advancements are made. The skills needed to maintain this equipment are generally

those characteristic of a good appliance repairman.

Although a routine scheduled maintenance program for this equipment is desirable, it can be handled on a demand maintenance basis. When a piece of A-V equipment breaks down, since it is a single item, it can be immediately replaced with an operable item while the inoperable item is repaired. And finally, A-V equipment consists of relatively low cost items. In a sample of A-V equipment inventories, it was found that the average cost on A-V equipment items was approximately $250.

TV and other communications systems equipment, on the other hand, is generally operated by professional and technically skilled engineering personnel. Each piece of equipment is generally a component in an equipment system, so that a failure of a single item is likely to make the whole system inoperable. The equipment is primarily electronic, and requires the knowledge and skills of an electronic technician for maintenance. For example, if the switcher in a closed circuit television system on the instructor's console for a rear screen projection system in a lecture hall breaks down, it must be repaired rather than replaced. Since this type of equipment is operated as a component of a system, it needs a definite schedule of maintenance to keep it up and running.

Special equipment is simply a catch-all category that may include a variety of relatively high-cost single items or systems, operated by professional or technical personnel and maintained by service contracts with commercial vendors. The purposes for using a service contract rather than local maintenance may vary. One good reason would be to get the benefits of

the warranty, because local skills are not sufficient to maintain the equipment. A second reason might be that it is simply less expensive to contract for services than to provide them locally. This, of course, is an alternative that should be examined with all new equipment purchases.

In this categorization of the equipment which we just concluded two terms were mentioned which require clarification. These terms are "scheduled maintenance" and "demand maintenance." It is necessary to understand their meanings in context with the use of the maintenance formulas because they have emerged from another question that required an answer--that question being, "What is maintenance and what does it include"?

The resultant answer is two-fold. This is because two levels of activities were identified--they being those responsibilities which can be classified as maintenance oriented, and those activities which are of such a nature as to take them outside the general bounds of normal maintenance operations.

Maintenance function classifications and their definition, which have been included in the formula, are:

1. Scheduled Maintenance: includes preventative maintenance, cleaning and operation of equipment.

2. Demand Maintenance: includes all nature of repairs, corrective maintenance and refurbishing of equipment.

The non-maintenance classifications and their definitions, which have not been included in the formula, are:

1. Supporting Services: includes alterations and modifications to facilities, correction of construction contractor deficiencies, completion of construction, equipment installation and service operations such as set-ups for special functions and improvements.

2. Contract Services: includes maintenance functions classified previously (scheduled and demand) but arranged for with an outside agency through service contracts.

As has been mentioned, several questions were initially asked regarding the equipment items themselves and their purposes. In partial fulfillment of these questions in the determination of maintenance formulas and requirements, it was necessary to initially establish categories and classifications to which the various equipment items might be assigned. They have been employed to reflect the uses of and the requirements placed upon educational communications equipment rather than being based solely on the equipment types. It should be noted that use of the equipment often has a much greater influence on the operation and subsequent maintenance of the equipment items than does the item itself. However, it is imperative that an understanding of the classification system employed herein be achieved in order to attain the most effective results from the recommended formulas. This is essential because it is not the equipment itself that determines its category and classification, but rather the use to which the equipment is put and the personnel involved.

The initial breakdown here involves the "who" and the "where" of equipment utilization, and generally involves the "what" which is either

"classroom," that is portable, or "system" equipment components. The "who" being chosen from students, teachers and professional or technical personnel. The "where" or "place" of the equipment is suggested simply as being either a learning space or a technical space.

Now we know the "who" that is involved, the "where" or "place" of equipment utilization and something about the "what" that has been established.

At this point we should elaborate a bit on this latter aspect, the "what" and generally note the elements of the rather all-inclusive categorical terms employed thus far, they being "classroom" and "system".

These can be generally considered as "equipment utilization categories." Definitions and equipment classifications for each are as follows.

First, "classroom" which is generally used by students and teachers.

The definition of classroom is that equipment which is of such a type and nature so as to be operated primarily by a teacher or student, and is generally portable.

The classification of equipment within the classroom category includes:

1. Audiovisual
2. Evaluation
3. Photography
4. Television-radio: portable

Secondly, "systems" which are generally used by the professional and technical personnel employed by the school or college.

The definition of systems is that equipment which the professional staff of an educational communications center requires in the acquisition, production, distribution, storage, retrieval and electronic testing functions for which they are responsible.

The classifications of equipment within the systems category includes:

1. Audiovisual
2. Evaluation
3. Graphics
4. Photography
5. Printing-Duplicating
6. Television-Radio
7. Electronic Testing

This classification system is quite general. There are numerous equipment items that can be justifiably assigned to A-V, TV or the special equipment category. The portable TV system is a good example. The system is made up of a vidicon TV camera, a half-inch videotape recorder, and a television receiver. It would seem that the maintenance responsibility for this equipment should be given to the TV department--it is electronic, a system and costs approximately $2,500. However, the primary operators of this equipment are a large number of different instructors and students. This

leads to a high incidence of minor maintenance problems which the A-V department has been set up to handle. Although this classification scheme has relatively loose categories, some means of categorizing appeared to be necessary in this analysis because maintenance costs were apparently different for these three categories of equipment.

The cost factors which contribute to annual maintenance expenditures are basically (1) supplies used in the repair or replacement of used parts of equipment items or systems, and (2) the personnel time involved in performing these activities. Of course, where maintenance is performed under a service contract the provisions of the contract define the cost factors.

Several cost factors associated with the installation, operation and maintenance of educational communications equipment were excluded from consideration.

First, maintenance personnel are often involved in the rehabilitation of spaces to accommodate new equipment and in the installation of this equipment. These are "one-time" costs and should be properly budgeted and accounted for as construction or rehabilitation costs. Secondly, the replacement of worn out equipment is an amortization problem and not a maintenance cost factor. Equipment maintenance costs and maintenance costs should not be mixed. Third, there is a start-up cost, including facilities and equipment, for beginning a maintenance program. Although the addition of tools and equipment for the maintenance shop is properly a part of annual maintenance expenditures, this one-time start-up cost should be

separately budgeted. And finally, the overall effects, influences, and values of equipment warranties. This latter point has been examined, but not thoroughly enough to merit any valid conclusion.

The analysis of equipment maintenance programs and the general guidelines that had been established provided the basis for conducting a survey of educational and commercial organizations that had adequate records and experience in the costs of maintaining communications equipment.

Sixteen colleges and school districts were identified as sources of maintenance cost data for the audiovisual survey.

The information which was gathered from each of the sources included in the survey was carefully selected so as to answer the questions that had been established and to provide data for the development of the equipment maintenance formula.

Under the audiovisual category the following specific sets of data were collected from each agency.

1. Source
2. Capital investment
3. Estimated total number of units
4. Number of maintenance technicians
5. Total annual maintenance hours
6. Total annual technician salaries
7. Total annual maintenance costs

From this information we were able to calculate the additional factors employed in the analysis, which include:

8. Maintenance personnel cost as a percentage of capital investment

9. Maintenance supply cost as a percentage of capital investment

10. Total maintenance cost as a percentage of capital investment

11. Totals

12. Averages

The totals were derived under each category and averages were found for each. The averages provide what is being recommended as an audiovisual equipment maintenance formula. It should be noted that there is considerable variance among these institutions in the percentage of capital investment that is expended annually for the maintenance of equipment.

However, the audiovisual equipment maintenance formula is:

Personnel--3.92% of total capital investment

Supplies and Expenses--2.7% of total capital

Investment, providing a total of 6.62% of the total capital investment for maintenance of audiovisual equipment.

The television survey was conducted in much the same manner.

Since adequate maintenance data were not available on the variety of new communications systems such as dial access systems, lecture hall communications systems, and the like, the survey included only television equipment systems. Television maintenance was the primary problem on State University campuses, and data on maintenance costs for these systems would, at least, provide educational communications centers with some fairly tight guidelines for budgeting electronic systems maintenance expenditures. Seven colleges closed-circuit television

installations, three educational television stations and five commercial television stations--a total of fifteen installations were used as sources of maintenance cost data. A summary of the television maintenance expenditures for these fifteen installations provides the television maintenance formula.

In deriving the formula for television equipment maintenance the following types of data was collected:

1. Source
2. Capital investment
3. Technical personnel
   a. total
   b. maintenance only
4. Total maintenance personnel cost
5. Total maintenance supplies (excluding VTR heads)
6. Total maintenance cost (personnal and supplies)
7. Total VTR hours
8. Total VTR head costs

From this information we were once again able to calculate the additional data required, including:

9. Maintenance personnel cost as a percentage of capital investment
10. Maintenance supply cost as a percentage of capital investment

11. Total maintenance cost as a percentage of capital investment

12. VTR hourly cost

13. Totals

14. Averages

In compiling this data, the average television maintenance technician's salary was found to be approximately $10,000. This average salary was used in the calculations. In deriving a formula to express the relationship of annual television maintenance costs to the total capital investment in television equipment it was also discovered that a major maintenance cost in operating a television system with quadraplex video-tape recorders is the VTR head cost. These costs, are a function of the number of hours of VTR operation, as opposed to the total capital investment for VTR's. Consequently, these costs were broken out and have been treated separately. A similar factor was learned regarding image orthicon camera tubes. You will therefore find this cost separated from the formula, as it too is a result primarily of the use to which it is put rather than the investment made.

With this background, the television equipment maintenance formula which has resulted may be summarized in the following manner:

Personnel--2.45% of the total capital investment

Supplies and Expenses--1.97% of the total capital investment

These two factors give us a television equipment maintenance formula of 4.42% of total capital investment. To this we must add the two

variable cost factors, should the installation warrant their application:

Quadrature VTR heads at $3.00 per hour of use, and image orthicon camera tubes at $1.00 per hour of use.

These two latter costs are for supplies and expenses, that is replacement parts, only and do not include personnel cost factors.

Specialized equipment, as mentioned earlier, is that which, for a variety of reasons, could best be assigned to a service contract. Arrangements for this, and the subsequent budget amounts which would be involved, are best handled locally.

With the two major educational communications equipment maintenance formula calculations in mind, I should like to provide you with an example of how it would work in a given situation.

This example, shows how these formulas can be used to estimate the maintenance budget for a campus educational communications center responsible for maintenance of an A-V equipment inventory worth $300,000, a TV equipment inventory worth $500,000, and a set of service contracts on computer terminals, photography and office equipment costing $1,700 annually.

This budget would allow the center 1.4 A-V maintenance technicians at an annual salary of $8,200 and 1.25 TV maintenance technicians at an annual salary of $10,000.

The totals for salaries and wages would be $24,010.

The second cost factor, supplies and expenses, would be budgeted at $24,950 and is comprised of the audiovisual equipment maintenance formula for supplies and expenses at $8,100 the television equipment maintenance

formula for supplies and expenses, at $9,850, 1500 hours of quadrature VTR head wear at $3.00 per hour for $4,500, 800 hours of image orthicon camera tube use at $1.00 per hour for $800 and service contracts for the computer terminals, photography and office equipment at $1,700.

The total educational communications equipment maintenance budget, according to the formulas for an $800,000 total inventory would be $48,960.

In conclusion, therefore, it is important to remember that the costs of maintaining educational communications equipment is a result of many interacting factors. These factors which must be considered and included in the use of the formula are such items as

--the amount of equipment

--the age of the equipment

--the amount and type of use it receives

--the nature of the equipment

--the quality of maintenance performed on it

--the local cost of maintenance personnel and supplies

With these factors in mind the purpose of this report was to provide schools and colleges with some empirical basis for estimating the annual cost of maintaining educational communications equipment.

The next task we all have is to test and evaluate the formulas in order to validate them or to provide concrete suggestions for their revision.